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Screening in Cancer Prevention and Early Detection

Screening is a public health strategy to reduce death and disability on a population basis.[1] It is the process of testing many apparently healthy people potentially at risk of a disease to identify individuals likely to develop the disease, or likely to have the disease at a presymptomatic stage. Screening tests do not give definitive diagnoses. They rapidly and inexpensively identify individuals who need further evaluation.

Population-based screening should not be confused with the clinical evaluation of an individual patient. A health care provider and patient may decide to perform clinical diagnostic tests based on family history, personal medical history, and lifestyle. Clinical evaluation of an individual may occur whenever that individual and his or her health care provider believe it is appropriate. In contrast, population-based screening is recommended only when *all* of the following are true:

- the disease is relatively common in a population,
- the disease has a pre-symptomatic phase that can be detected by screening,
- a suitable screening test exists,
- adequate follow-up and diagnostic capacity are available,
- effective intervention or treatment is available, and
- the disease can be prevented from progression by early intervention or there is credible evidence that early intervention or treatment offers advantages over later intervention or treatment.

Screening requires a test that is accurate, safe, acceptable to patients, easy to perform, and relatively inexpensive. An ideal screening test is both sensitive (does not miss true cases) and specific (gives few false positive results).[2] No screening test can simultaneously detect all true cases and eliminate all non-cases, so a balance must be struck between acceptable sensitivity and specificity. False positive screening results may occur for several reasons:

- the test detects a condition that is a necessary step in the disease process, but does not always progress to disease;
- the test detects a condition that indicates increased risk for disease, but is not a step in the disease process;
- the test does not produce a simple positive or negative result but a range of values, and the critical value used to identify increased risk may emphasize sensitivity (trying to find all potential cases) at the expense of specificity (leads to increased number of false positives).

There are many conditions for which very accurate screening methods are available, but for which effective treatments are not, depriving screening of practical significance. For other conditions, treatment may be available but there is no credible evidence that treatment increases quality of life or life expectancy.

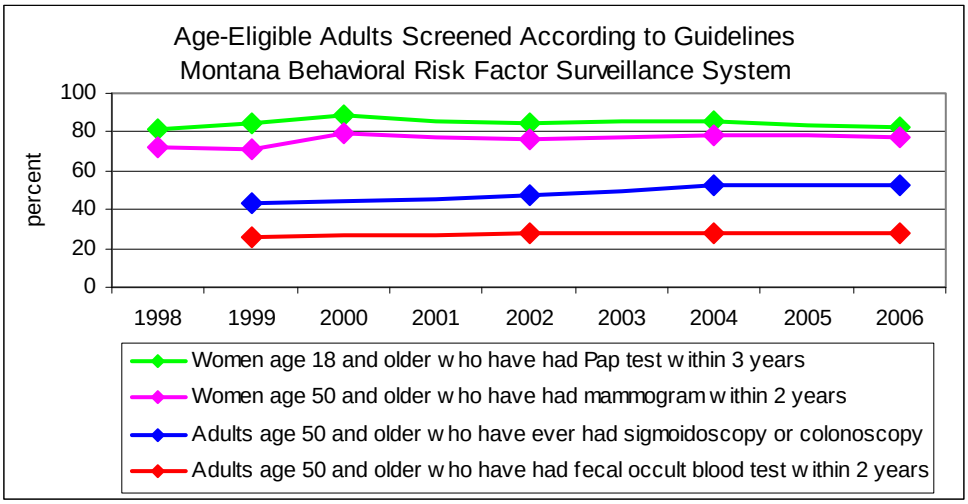
[1] JMG Wilson and G Junger, 1968. *Principles and Practice of Screening for Disease*. Geneva, Switzerland: world Health Organization.
[2] Lilienfeld DE and Stolley PD. 1994. *Foundations of Epidemiology*, 3rd ed. New York: Oxford University Press.

The United States Preventive Services Task Force (USPSTF) is the leading independent panel of private-sector experts in prevention and primary care. U.S. Public Law Section 915, enacted in 1984, mandates that the USPSTF convene periodically to conduct scientific evidence reviews and develop screening practice recommendations for the health care community. The USPSTF conducts rigorous, impartial assessments of the scientific evidence about the effectiveness of preventive services, including screening. Panels convene whenever there is a substantial increase in the accumulated evidence base to consider updating previous recommendations. Their recommendations are considered the gold standard for preventive services.

Evidence-based recommendations for universal screening exist for breast cancer, colorectal cancer, and cervical cancer.[3] Universal screening for prostate and lung cancer are not recommended at this time.[4] Clinical trials are under way to evaluate new screening technologies, including their sensitivity, specificity, and impact on life expectancy and quality of life. The USPSTF will revisit its position on screening recommendations for prostate and lung cancers when the studies are concluded.

Screening Participation, Stage at Diagnosis, and Survival in Montana

Participation in Pap testing and mammography are fairly high in Montana, at 82% and 77% of age-eligible women, respectively, in 2006.[5] Montana women have participated in Pap testing and mammography at high levels for many years.[5] Unfortunately, participation in colon cancer screening by either annual fecal occult blood testing or colonoscopy is lower: 28% and 53%, respectively, in 2006 and there has been little change since 1999.[5]

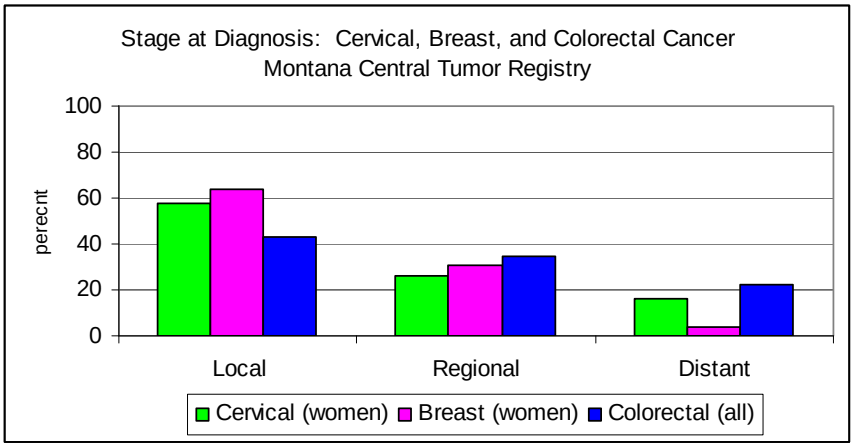


One of the primary goals of cancer screening is to find precancerous changes so cancer may be prevented, or to find cancer at an early stage when treatment is most effective. For the majority of cancers, survival is directly related to the stage at diagnosis. Cancer is usually divided into four broad stages:

[3] http://www.ahrq.gov/clinic/uspstf/uspsbrca.htm; http://www.ahrq.gov/clinic/uspstf/uspscolo.htm; http://www.ahrq.gov/clinic/uspstf/uspscolo.htm;
[4] http://www.ahrq.gov/clinic/uspstf/uspsprca.htm; http://www.ahrq.gov/clinic/uspstf/uspslung.htm
[5] http://apps.nccd.cdc.gov/brfss/

- In situ: cancer cells have not spread to surrounding tissues.
- Local: cancer cells are not found outside the organ of origin.
- Regional: cancer cells are found in surrounding lymph nodes or other tissues adjacent to the organ of origin.
- Distant: cancer cells are found in other parts of the body.

Differences in participation in cancer screening for cervical, breast, and colorectal cancer are reflected in substantial disparities in stage at diagnosis. Sixty-five percent of women with breast cancer and 58% of women with cervical cancer were diagnosed at the local stage in Montana in 2005, but only 43% of patients with colorectal cancer were diagnosed at the local stage. Even more troubling, 22% of patients with colorectal cancer were diagnosed at the distant stage.



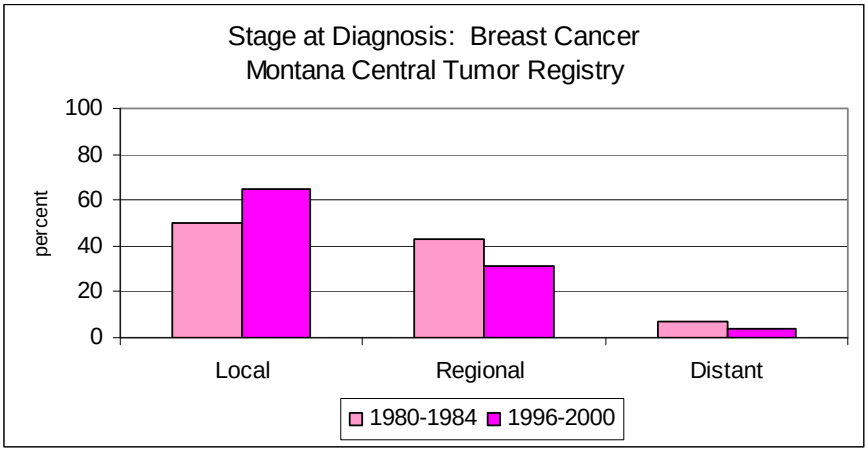
The Papanicolau (Pap) smear screening test for cervical dysplasia is the basis of the most effective cancer prevention screening program ever undertaken.[6] In 1900, cervical cancer was the leading cause of cancer death among women in the United States.[7] Although cervical cancer continues to take many lives throughout the world, in the United States it is now a rare diagnosis and an even rarer cause of death, thanks to very widespread screening. This was accomplished because health care providers incorporated Pap tests into most routine clinical encounters with women. It was further facilitated by the relative ease of interpretation of the histological samples and the relatively low cost of the test. Cervical cancer is now considered preventable with screening at appropriate intervals, leading to early detection and treatment of precancerous lesions.

Breast cancer is the most common cancer among women in Montana.[8] For women diagnosed between 1980 and 1984, 77% survived at least five years after diagnosis. For women diagnosed between 1996 and 2000, 93% survived at least five years. This is in part because stage at diagnosis improved substantially during this time period. Diagnosis at the local stage increased from 50% in 1980 to 65% in 2005.

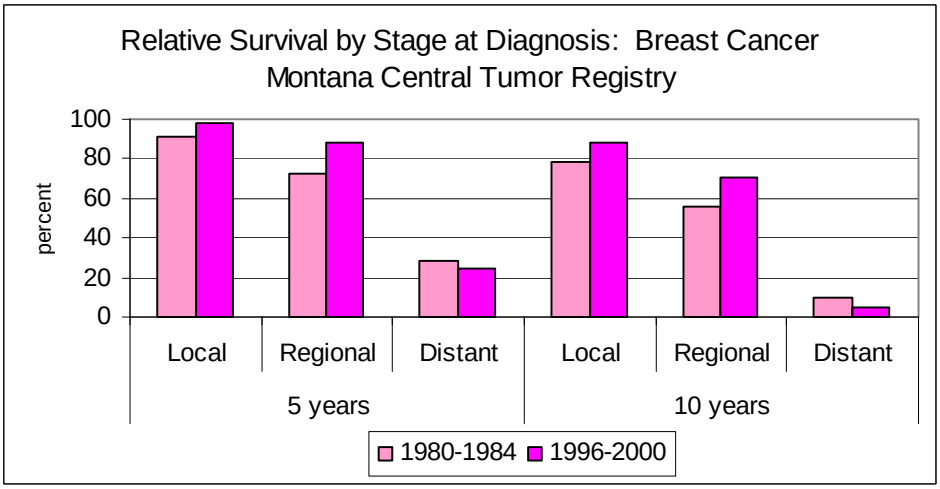
Five-year survival for women diagnosed at the local stage improved from 91% in 1980-84 to 98% in 1996-2000, and survival for women diagnosed at the regional stage improved from 73%

[6] American College of Obstetrics and Gynecology, 2003
[7] http://www.cdc.gov/cancer/cervical/statistics/
[8] Montana Central Tumor Registry

to 88%. Ten-year survival also improved, from 78% for women diagnosed at the local stage in 1980-84 to 88% in 1996-2000, and from 42% to 54% for women diagnosed at the regional stage. Increased survival at each stage suggests that there have also been improvements in treatment.

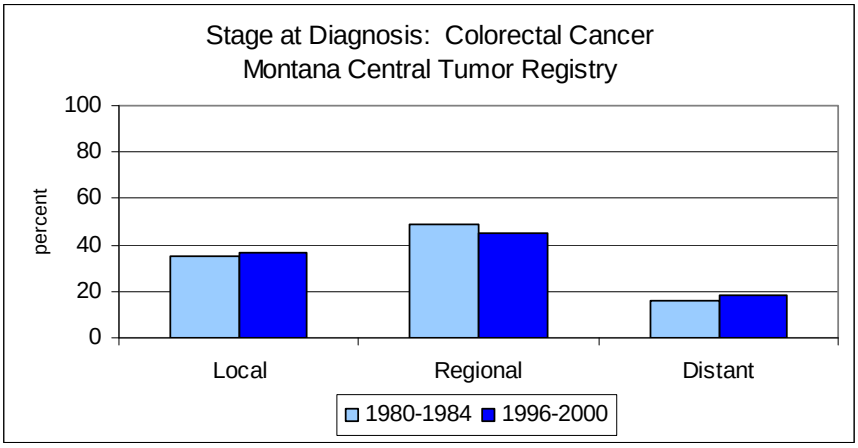


Early diagnosis of breast cancer has been accomplished by encouraging women to have annual mammograms after age 50. Mammography requires referral for another appointment outside the primary caregiver's office, which may reduce compliance. The cost of mammography is also higher than the cost of Pap tests. Breast cancer is not preventable with mammography but can be detected at an early stage when treatment may be very effective.

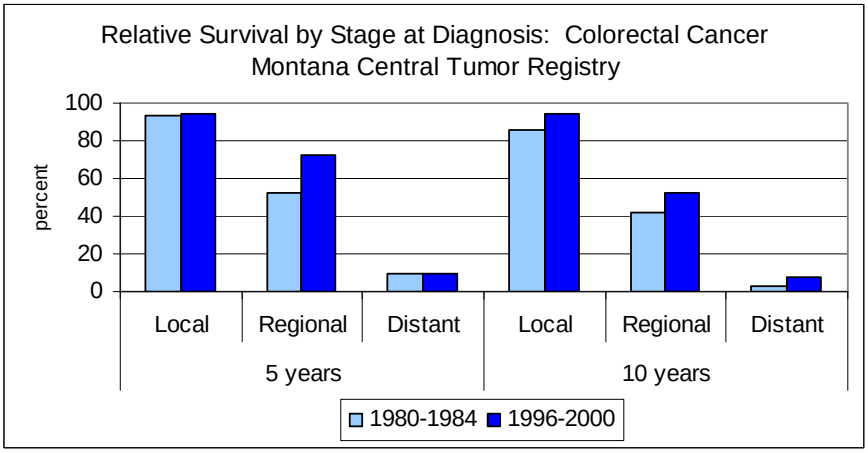


Colorectal cancer is the fourth most common incident cancer in Montana and the fourth most common cause of cancer death.[9] Many cases could be prevented with screening. Most colon cancers start as polyps that can be removed during a colonoscopy. Among Montana residents with colorectal cancer, fewer than 40% are diagnosed at the local stage, nearly half are diagnosed at the regional stage, and more than 20% are diagnosed at the distant stage. Stage at diagnosis has not improved in the past 20 years.

[9] Montana Central Tumor Registry



In spite of little change in stage at diagnosis, colorectal cancer survival has improved, suggesting improvements in treatment.



Costs and Cost-Effectiveness of Screening

The cost-effectiveness of screening can be evaluated from an individual perspective or on a population basis. At the individual level, the average cost of screening colonoscopy, plus polyp removal and pathology evaluation if a polyp is discovered, is approximately $1,500. The average cost of treatment of colon cancer is $58,000 in the first year after diagnosis.[10] Screening and prevention are far less expensive than treatment.

On a population basis, the cost-effectiveness of screening is calculated as the total cost of screening (summed across all people screened) for each year of life saved by early detection, adjusted for the prevalence of cancer in the population screened, the sensitivity and specificity of the test, the recommended screening interval, and necessary follow-up for positive results. This is the perspective of third-party payers and health policymakers.

[10] Frazier AL et al. 2000. *JAMA* 284:1954-1961.

Fecal occult blood testing is the least expensive procedure, but factoring in the number of people to be screened each year, the low specificity of the test, and the need to follow up a large number of false positives, annual fecal occult blood testing is approximately as expensive as colonoscopy on a population basis. Colonoscopy is the most expensive procedure, but is recommended only once every 10 years, is highly sensitive and specific, and may prevent colon cancer if polyps are removed during the procedure. Mammography is less expensive than colonoscopy on a per-test basis, but cost adjusted for screening interval and the number of women eligible to be screened is higher on a population basis. Pap tests are inexpensive on a per-test basis, but many women are eligible to be screened and few have precursor lesions for cervical cancer, so the cost per life-year saved is higher than for the other screening procedures.

	Average estimated cost per life-year saved
Fecal occult blood test annually	$ 13,000[13]
Colonoscopy every 10 years	$ 10,000[11]
Mammography annually	$ 22,000[12]
Pap smear every 3 years	$ 250,000[13]

More than 650 cases of breast cancer are diagnosed in Montana each year and almost 500 cases of colorectal cancer. Only lung cancer (665 per year) and prostate cancer (860 per year) are diagnosed more often. Breast and colorectal cancers are the third (23.9 per 100,000) and fourth (17.3 per 100,000) most common causes of cancer death, after lung (52.6 per 100,000) and prostate (28.8 per 100,000) cancers. Cervical cancer ranks only 19th in incidence in Montana now, and even lower as a cause of death, thanks in large part to aggressive screening practices. Decreases in breast cancer mortality have occurred over the past 20 years and this trend could continue with the extension of consistent mammography services to underserved women. Similar substantial decreases in colorectal cancer incidence and mortality could be realized with equally aggressive population-based screening.

Please visit our website at www.cancer.mt.gov

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[11] Provenzale D. 2002. *Gastroint Endosc Clin N Am* 12:93-109; Maciosek MV et al. 2006. *Am J Prev Med* 31:80-89.
[12] van der Maas PJ et al. 1989. *Int J Cancer* 43:1055-1060.
[13] Eddy DM. 1990. *Ann Intern Med* 113:214-226.